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Synthesis and characterization of $K_2Ca_5(SO_4)_6 \cdot H_2O$, the equivalent of görgeyite, a rare evaporite mineral

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Abstract

Görgeyite, $K_2Ca_5(SO_4)_6 \cdot H_2O$, is a very rare monoclinic double salt found in evaporites related to the slightly more common mineral syngenite. At 1 atmosphere with increasing external temperature from 25 to 150 °C, the following succession of minerals was formed: first gypsum and K_2O, followed at 100 °C by görgeyite. Changes in concentration at 150 °C due to evaporation resulted in the formation of syngenite and finally arcanite. Under hydrothermal conditions, the succession is syngenite at 50 °C, followed by görgyeite at 100 and 150 °C. Increasing the synthesis time at 100 °C and 1 atmosphere showed that initially gypsum was formed, later being replaced by görgeyite. Finally görgeyite was replaced by syngenite, indicating that görgeyite is a metastable phase under these conditions. Under hydrothermal conditions, syngenite plus a small amount of gypsum was formed, after two days being replaced by görgeyite. No further changes were observed with increasing time. Pure görgeyite showed elongated crystals approximately 500 to 1000 μm in length. The infrared and Raman spectra are mainly showing the vibrational modes of the sulfate groups and the crystal water (structural water). Water is characterized by OH-stretching modes at 3526 and 3577 cm^{-1}, OH-bending modes at 1615 and 1647 cm^{-1}, and an OH-libration mode at 876 cm^{-1}. The sulfate ν_1 mode is weak in the infrared but showed strong bands at 1005 and 1013 cm^{-1} in the Raman spectrum. The ν_2 mode also showed strong bands in the Raman spectrum at 433, 440, 457, and 480 cm^{-1}. The ν_3 mode is characterized by a complex set of bands in both infrared and Raman spectra around 1150 cm^{-1}, whereas ν_4 is found at 650 cm^{-1}.